

**SAINT PAUL'S HOSPITAL MILLENNIUM MEDICAL
COLLEGE DEPARTMENT OF EMERGENCY AND
CRITICAL CARE MEDICINE**

PATTERN AND OUTCOME OF CERVICAL SPINE INJURY

**A RESEARCH PAPER TO BE SUBMITTED TO THE
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**INVESTIGATOR: ALEMAYEHU BEHARU (MD,EMERGENCY AND
CRITICAL CARE MEDICINE RESIDENT)**

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Medicine**

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Investigator: Alemayehu Beharu (MD, Emergency and Critical Care Medicine Resident)

Advisors:

- 1. Dr. Ayalew Zewde (Associate Professor of Emergency and Critical care Medicine)**
- 2. Dr. Daniel Aman (Assistant Professor of Emergency and Critical care Medicine)**

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Name of investigators	Dr. Alemayehu Beharu
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Address of investigators	Cell phone -+251919306766 /+251918897979
	Email – cspineoutcome@gmail.com
Name and address of advisors	Dr Ayalew Z. Cell phone no: +251960367958
	Email:..... Dr. Daniel A. Cell phone no:+251913636689 Email:

Assurance of principal Investigator

I undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress report to my advisor and seek the necessary advice and approval from my primary advisors in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name of the student: _____

Signature: _____

Date: _____

Approval of the Primary Advisor

Name of the primary advisor: _____

Signature: _____

Date: _____

Approval of the Co-Advisor

Name of the Co-Advisor: _____

Signature: _____

Date: _____

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Table 1: List of Abbreviation and acronyms

SCI	Spinal cord injury
C-spine injury	Cervical spine injury
ASIA	American spine injury associations
AaBET	Addis Ababa Burn Emergency and trauma
SPHMMC	Saint Paul hospital millennium medical collage
PLOS	Prolonged length of hospital stay
LOS	Length of stay
EMCC	Emergency medicine and critical care
RTA	Road traffic accident
FDA	Falling down accident
ED	Emergency department
ICU	Intensive care unit

ABSTRACT

Background: Cervical spine injury is a common problem with a wide range of severity from minor ligamentous injury to frank osteo-ligamentous instability with spinal cord injury (1). The most common causes of cervical spine injury are automobile accidents, followed by diving into shallow water, firearm injuries, and sports activities (2). And in elderly group of people low energy fall from a standing height and high energy motor collisions are a common cause of c-spine injury (3).

Patients with complete cervical injuries had high rates of mortality and morbidity but there is a moderate recovery rate in patients with incomplete SCI despite a lack of adequate rehabilitation facilities (5)

In developing countries like Ethiopia, little is known about the prevalence of cervical spinal injuries. An understanding of the prevalence of spinal injury is very important to develop possible preventive strategies and improve our primary trauma care. In addition, it helps to identify the risk factors and causes of spinal trauma thus helping to formulate preventive measures.

Objective: To assess the pattern, outcome and associated factors of patients with C-spine injury visited AaBET Hospital ED from January 2018 to December 2022, Addis Ababa.

Methods and Results: Institution based cross sectional study was conducted at AaBET hospital, Addis Ababa, Ethiopia. The study included patients presented to the emergency department with a diagnosis of cervical spine injury during a period of January 1, 2018 to November 1, 2023. A total duration of 5 years and 10 months. Data was collected by structured data extraction format from patient's chart and analyzed by SPSS version 25.0. Descriptive analysis was used for statistical analysis of baseline data, and regression analysis was used to determine associations between dependent and independent variables. A p-value <0.05 was considered significant. Tables and figures were used to present the results. A total data of 149 patients were analyzed, with an average age of 36.3 ± 14.9 years (ranges 9-85 years) and the male to female ratio was 2.9:1.

The most common mechanism of cervical spine injury is Road traffic accident (49.7, followed by falling down accident (39.6%) of patients. Seventy eight (52.3%) patients sustained a total of 114 associated injuries (ASOI). Head injury was the common associated injury followed by chest and extremity injury. The most frequently injured cervical vertebra was C 7 followed by C6 and T1. And 68.5% of the patient has multilevel injury. 33.6% of patients has neurological impairment ASIA class A followed ASIA class E (29.5%).

The overall hospital mortality is 7.4%. The level of cervical spine injury, the ASIA class of the patient and the presence of associated injury were strongly associated for mortality.

The median length of hospital stay was 6 days (IQR 18). And 30.2% of patients has prolonged length of hospital stay (PLOS). Neurosurgical intervention and the presence of associated injury particularly strongly associated with PLOS.

Conclusion: This study showed the common mechanism was RTA and C7 was the common injury level. C3 injury level, ASIA A neurologic deficit and having associated injury were associated with mortality. Undergoing neurosurgical intervention and the presence of associated injury were associated with prolonged length of hospital stay (PLOS).

Key words: Cervical spine, pattern, outcome, associated factor

1. Introduction

1.1. Background

According to the National Spinal Cord Injury Statistical Center, motor vehicle collisions (MVCs) account for 39% of all spinal injuries. (6) Speeding, alcohol intoxication, and failure to use restraints are major risk factors. The next most common cause of spinal cord injury (SCI) is falls, followed by acts of violence (primarily gunshot wounds) and sporting activities. Approximately 80% of victims are male, and the average age at injury is 43 years. The lifetime cost to care for SCI victims ranges from over \$1 million if older than 50 years, with incomplete motor function, to over \$5 million for those younger than 25 years, with complete paraplegia. The total cost to society from lifelong medical expenses and lost productivity for all ages and types of spinal injuries is estimated to be more than \$5 billion. The devastating emotional and psychological impact is incalculable.

Cervical spine fractures are the most common fractures of the spine and most often associated with SCI.

In 1996, Hu et al. reported the incidence of spine fractures, all sites, to be 64/100,000. However, sub grouping into cervical, thoracic or lumbar fractures was performed for only 45% of the patients. The assumed incidence of cervical fracture can be estimated to be 12/100,000 based on this study, which was performed on a population in Canada. {Citation} (8)

The human spine consists of 33 bony vertebrae—7 cervical, 12 thoracic, 5 lumbar, 5 sacral (fused into one), and 4 coccygeal (usually fused into one). These 26 individual units are separated from one another by flexible intervertebral disks and connected to form a single functioning unit by a complex network of ligaments. The vertebral column protects the spinal cord, which extends from the midbrain to the level of the second lumbar vertebra.

Spinal injuries involve fractures in 85% of cases. In the remainder, 10% are ligamentous injuries without fracture, and 5% are SCIs without a radiographic abnormality (SCIWORA), in which the spinal cord is injured directly without radiographic evidence of bony or ligamentous injury.

Cervical spinal cord injury (SCI) is a devastating event for the patient and family. It has a huge impact on society because of the intensive resources required to manage the patient in both the acute and rehabilitation phases.

Given the limited study conducted in our country, this study will be able to describe Pattern and Outcome of patients with C-spine injury visited AaBET Hospital, affiliates of St.Paul's Hospital Millennium Medical College Emergency Department from January 2018 to December 2022, Addis Ababa, Ethiopia

1.2. Statement of the problem

The cervical spine is a dynamic structure tasked with protecting nervous innervations to the entire body while also maintaining a range of motion for the head and neck. Fractures of the cervical spine are a leading cause of morbidity and mortality in trauma patients, and a bone fracture is associated with 56% of cervical spinal cord injuries. (8) There is a bimodal age distribution among patients with SCI: the first peak occurs in patients between 15 and 24 years, and the second in patients over 55 years of age. (2)

The incidence of cervical spine injury in patients with moderate and severe head injury has been reported to range between 1.8% and 9%. Some authors, though not all, report that patients in a trauma population with clinically significant head injuries are at greater risk of cervical spine injury than those without head trauma and that patients with a severe head injury (GCS $\leq$ 8) are at even greater risk. Conversely, the incidence of moderate to severe head injury in patients with cervical spine injury is reported to be 18 – 40 %.(8)

Spinal cord injury is a devastating, life changing condition, and poses a major challenge for clinicians to manage in resource constrained regions. Previously, SCI patients died within few years of trauma. Though status of morbidity and mortality has gradually improved in developed countries, it is still lacking in developing nations.

Even after treatment and rehabilitation, the life expectancy after spinal cord injury has been observed to be less than the general population. Because of the cardio-pulmonary complications associated with cervical spine trauma, ICU admission becomes necessary and a large subset of these patients eventually require respiratory support in the form of assisted ventilation. (7)

However, there is limited study on the outcome of these patients with ICU admissions in a government hospital setup in an underdeveloped country.

In developing countries like Ethiopia, little is known about the prevalence of spinal injuries. An understanding of the prevalence of spinal injury is very important to develop possible preventive strategies and improve our primary trauma care. In addition, it helps to identify the risk factors and causes of spinal trauma thus helping to formulate preventive measures.

So with this study we expect to build knowledge and understanding about the pattern of cervical spine injury and the outcome of patients who sustained this injury who visited our hospital.

1.3. Significance of the Study

Every year, around the world, between 250 000 and 500 000 people suffer a spinal cord injury (SCI). The majority of spinal cord injuries are due to preventable causes such as road traffic crashes, falls or violence.(8) Mortality risk is highest in the first year after injury and remains high compared to the general population. People with spinal cord injury are 2 to 5 times more likely to die prematurely than people without SCI.(8)

Mortality risk increases with injury level and severity and is strongly influenced by availability of timely, quality medical care. Transfer method to hospital after injury and time to hospital admission are important factors.

Preventable secondary conditions (e.g. infections from untreated pressure ulcers) are no longer among the leading causes of death of people with spinal cord injury in high-income countries, but these conditions remain the main causes of death of people with spinal cord injury in low-income countries.

Spinal cord injury is associated with a risk of developing secondary conditions that can be debilitating and even life-threatening—e.g. deep vein thrombosis, urinary tract infections, muscle spasms, osteoporosis, pressure ulcers, chronic pain, and respiratory complications. Acute care, rehabilitation services and ongoing health maintenance are essential for prevention and management of these conditions.

Spinal cord injury may render a person dependent on caregivers. Assistive technology is often required to facilitate mobility, communication, self-care or domestic activities. An estimated 20-30% of people with spinal cord injury show clinically significant signs of depression, which in turn has a negative impact on improvements in functioning and overall health.

Misconceptions, negative attitudes and physical barriers to basic mobility result in the exclusion of many people from full participation in society. Children with spinal cord injury are less likely than their peers to start school, and once enrolled, less likely to advance. Adults with spinal cord injury face similar barriers to economic participation, with a global unemployment rate of more than 60%.

The leading causes of spinal cord injury are road traffic crashes, falls and violence (including attempted suicide). A significant proportion of traumatic spinal cord injury is due to work or sports-related injuries. Effective interventions are available to prevent several of the main causes of spinal cord injury, including improvements in roads, vehicles and people's behavior on the roads to avoid road traffic crashes, window guards to prevent falls, and policies to thwart the harmful use of alcohol and access to firearms to reduce violence.(2,3,8)

In Ethiopia study done on patients with cervical spine injury regarding to its pattern and outcome is limited. However, from the global data the burden of this injury is high and is increasing from time to time in alarming rate posing major negative consequence on the life of individuals and it is a huge burden to the society at large.(5,7,9,10).

So this study is expected to build on the existing knowledge and understanding about pattern and outcome of patients with cervical spine injury to prevent and minimize its negative health impact. It will also use for health professionals and other stake holders to improve their practice with respect to handling of patients with possible cervical spine injury.

2. Literature review

2.1. Background

The human spine consists of 33 bony vertebrae: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral (fused), and 4 coccygeal (usually fused). These 26 individual units are separated by intervertebral disks and connected by a network of ligaments. The vertebral column provides the body's basic structural support and protects the spinal cord, which extends from the midbrain caudally to the level of the second lumbar vertebra and then continues as the cauda equine. Due to its exposed location above the torso and its inherent flexibility, the cervical spine is the most injured part of the spinal column. Within the cervical spine, the most common sites of injury are around the second cervical vertebra (C2, or axis) or in the region of C5, C6 and C7.(11)

Acute cervical spinal column injury may be classified according to the stability of the injury, its location, or the mechanism (flexion, flexion-rotation, extension, and vertical compression)

To assess the stability of cervical spinal column injuries below C2, the spine is viewed as consisting of two columns. The anterior column is formed by vertebral bodies and intervertebral disks, which are held in alignment by the anterior and posterior longitudinal ligaments. The posterior column, which contains the spinal canal, is formed by the pedicles, transverse processes, articulating facets, laminae, and spinous processes. The nuchal ligament complex (supraspinous, interspinous, and infraspinous ligaments), capsular ligaments, and ligamentum flavum hold the posterior column in alignment.

If both columns are disrupted, the cervical spine can move as two independent units, and there is a high risk of causing or exacerbating a spinal cord injury. In contrast, if only one column is disrupted and the other column maintains structural integrity, the risk of spinal cord injury is far less. (12, 13)

Failure to diagnose a cervical spine injury at the time of presentation can have disastrous consequences, with a risk for neurological deterioration in up to 67% of patients. (11)

2.2. Functional anatomy

The upper cervical spine has unique anatomic features that distinguish it from the remainder of the cervical spine. Its motion segments make up a large amount of total cervical spine motion and, as a result, predispose it to a unique set of injuries.

The occipitoatlantal range of motion is 25 degrees in flexion-extension and 5 degrees in rotation, whereas the atlantoaxial range of motion makes up a large proportion of the cervical motion in rotation, accounting for approximately 40-50% of cervical rotation. The atlantoaxial articulation also contributes 20 degrees to the flexion-extension range of motion. (1, 2)

The range of motion in the lower cervical spine is greatest at C4-5 and C5-6, although the relative contribution of each level is fairly evenly distributed amongst all the levels.

The anatomic features of each cervical motion segment predispose the levels to different patterns of injury and, as a result, require an evaluation of each individually.

Upper Cervical Spine Injuries (Base of skull-C2)

Occipitocervical dissociation

Occipitocervical dissociation is an uncommon injury which can be difficult to identify and has a high mortality. The most common mechanism of injury is that of a pedestrian struck by a car, with a high incidence in pediatric patients. (1)

Occipital condyle fractures

Occipital condyle fractures have previously been viewed as relatively uncommon injuries; but with the increased utilization of CT scanning with reconstructions in the evaluation of suspected spine trauma patients, an increased incidence has been noted. It has been reported to occur in 3-15% of trauma patients. (14, 15)

Atlas fractures

Atlas fractures are common cervical spine fractures, constituting 10% of all cervical spine fractures. (14). they have a high incidence of association with other cervical spine fractures. (16)

Odontoid fractures

Odontoid fractures are common cervical spine fractures, representing up to 20% of all cervical spine fractures in some studies.^{58,59} They have a bimodal incidence, with the first peak occurring in young patients in association with high energy trauma; and the second peak occurring in elderly patients in association with low-energy mechanisms, such as falls. These injuries commonly have no neurological involvement, although a spectrum of injury – from mild upper extremity weakness to complete quadriparesis – can be seen. (17, 18)

Sub axial cervical spine trauma (C3-T1)

Sub axial cervical spine injuries represent a broad array of injury patterns and degrees of instability. The current classification systems that are most commonly employed are mechanistic classifications, which, while useful for categorizing the injury patterns, do not reliably predict stability and management.

2.3. Epidemiology and outcome

The incidence of traumatic cervical spine fractures in the general population is largely unknown. Several reports describe the incidence of cervical spine fracture in different sub populations, such as trauma center patients, specific age groups, head injury patients, military populations and osteoporotic patients.(19–22)

One prospective study conducted in Norway³¹⁹ patients with CS-fx at one or more levels were registered over a one year period, constituting an estimated incidence of 11.8/100,000/year. The median age of the patients was 56 years (range 4–101 years), and 68% were males.

The trauma mechanisms were falls in 60%, motorized vehicle accidents in 21%, bicycling in 8%, diving in 4% and others in 7% of patients. Among 319 patients 79% of patients have normal neurologic status, 8% had an incomplete spinal cord injury (SCI), 2% had a complete SCI. The mortality rates after 1 and 3 months were 7 and 9%, respectively. Among 319 patients, 26.6% were treated with open surgery, 68.7% were treated with external immobilization with a stiff collar and 4.7% were considered stable and not in need of any specific treatment. (22)

One study conducted at the Shiraz University of Medical Sciences, Shiraz, IR Iran shows motor vehicle collisions are the most frequent trauma mechanism leading to cervical spine injury, with falls the second most frequent. This study demonstrated that most victims of CS are 16 to 40 years of age. A male predominance was observed, and the rate of SCI was 3.62% of all cases and the mortality rate was 6.18 %. (23)

A four year retrospective study conducted in Stanford University indicated traffic accidents induced significantly more fractures of the cervical and thoracic spine, while fall related fractures were evenly distributed over the whole spine. Sixty-five percent of all cervical spine fractures were accompanied by an associated injury. The highest incidence of associated injuries was observed in patients with multilevel fractures (96.5%). The highest number of complete motor and sensory neurological deficits was found in cervical spine fractures (19.7%). (24)

Higashi T et al and conducted a study on a risk factors associated with mortality in patient with traumatic cervical spinal cord injury and found that A total of 16 (30%), 4 (7%), 22 (41%), and 12 patients (22%) were scored A, B, C, and D, respectively, on the ASIA impairment scale. Most of the injuries were at the C4 (30%) and C5 (33%) levels. Falls from standing (35%) and heights (39%) were the most common injury mechanisms. (34).

Philipp Leucht et al 2008 on his paper on Epidemiology of traumatic spine fractures stated that associated injuries were a common finding in his study population. Patients sustaining an associated injury were on average six years younger than patients with an isolated spine fracture. This observation correlated with the distinct age distribution of patients with high-energy traumas, which increased the probability of suffering from an ASOI. The most common associated injuries were those to the head, thorax and extremities (24)

Ali R. Bokhari et al reported that the most common concomitant injuries were long bone fractures (11.6%), rib fractures (11.1%) and head injuries (7.6%) and significant predictive factors for complications and death in patient with cervical spine injury were neurological deficits, comorbidities and the presence of other injuries ($P < 0.05$) and (40).

Several investigations have demonstrated that elderly patients with a low-energy cervical spine fracture demonstrate outcomes similar to younger patients with a high-energy fracture. The presumed reasons for this trend include a reduction in functional reserve, a higher risk of airway compromise and urinary tract infections, and an increased risk of associated cardiac events in older people. A 15 years a retrospective review of all cervical spine fractures in patients sixty-five years of age or older conducted at two institutions at Brigham and Women's Hospital,

Boston, Massachussets shows among the 640 patients, the risk of mortality was 19% at three months and 28% at one year. Operative treatment of cervical spine fractures is associated with a lower mortality rate at three months but not at one year postoperatively for patients between sixty-five and seventy-four years old at the time of fracture.(3)

Out of 48 patients admitted to the ICU of one of the tertiary government referral trauma unit, 36 patients (75%) presented with ASIA A. Mechanical ventilation was required in more than 95 % of the patients. The average stay in ICU was 15 days and 13 patients died in the ICU. (7)

A prospective cross sectional survey was conducted from October 2013 to March 2014 in the Adult Emergency Centre of Tikur Anbessa Specialised Hospital. Eighty-four patients with traumatic spinal cord injuries were identified. The mean age was 33 years and 86% were male. The most common mechanisms of injury were motor vehicle collisions (37%), falls (31%), and farming injuries (11%). The cervical spine (48%) was the most commonly injured region and 41% were complete spinal cord injuries. (25)

A four year hospital based retrospective cross sectional study conducted at Tikur Anbessa Specialized Teaching Hospital (TASTH) identified 385 patients with spine and spinal cord injury, 127 patients (33%) had cervical spine injury. Fall from height was the main cause of spine and spinal cord injury (36.3%). The mean age was 32.8 years, with range 10 to 84 years. Peak age incidence was in 21-30 age groups (45.5 %). (26)

A three year retrospective study conducted to assess complications and outcome in patients surgically treated for subaxial spinal injuries in 2 hospitals in Addis Ababa, Ethiopia, A total of 85 patients were included, and 20 patients were not followed up. The mean age was 33 years and the mean time from injury to surgery was 10 days. Deaths occurred in 13 of 16 patients (81.1%) with American Spine Injury Association (ASIA) scores of A and in 3 of 16 patients (18.9%) with ASIA scores of B. The complication rate in patients with a preoperative ASIA score of A was 17/24 (70.8%). But Patients with ASIA grades C and D experienced at least 1 grade of improvement in 66.6% and 53.8% of cases, respectively. (5)

Katherine E. Pierce et al on his paper factors influencing length of stay following cervical spine surgery did LOS outcome analysis grouping patients by length of inpatient hospital stay: extended (E-LOS; >75th percentile) and normal (N-LOS; <75th percentile).(42) And Kobayashi, MD on his multicenter study assessing predictors of prolonged length of stay after lumbar interbody fusion, categorized patients as having a normal LOS (<75th percentile LOS) or prolonged LOS (>75th percentile LOS).(43).

Longer hospital length of stay (LOS) has been associated with many undesirable consequences. Prolonged LOS has been shown to increase healthcare costs and resource utilization. One large multi-center study analyzing factors contributing to a longer length of stay in adults admitted to a quaternary spinal care center, found that Mean LOS for the population (SD) was 15.8 (34.0) days. Factors significantly associated with longer LOS were advanced patient age, emergency admission, ASIA grade, operative management and the occurrence of one or more associated injuries. (41).

3. Objective

3.1. General Objective

- To assess the Pattern, Outcome and associated factors of patients with C-spine injury visited Emergency department(ED) of AaBET Hospital, from January 2018 to November 2023, Addis Ababa.

3.2. Specific Objectives

- To describe the socio-demography of patients with C-spine injury visited AaBET Hospital , affiliates of St. Paul's Hospital Millennium Medical College Emergency Department from January 2018 to November 2023, Addis Ababa
- To assess the pattern of C-spine injury among patients visited AaBET Hospital, affiliates of St. Paul's Hospital Millennium Medical College Emergency Department from January 2018 to November 2023, Addis Ababa.
- To assess the outcome of patients with C-spine injury visited AaBET Hospital, affiliates of St. Paul's Hospital Millennium Medical College Emergency Department from January 2018 to November 2023, Addis Ababa.
- To assess the associated factors associated with mortality in patients with C-spine injury visited AaBET Hospital, affiliates of St. Paul's Hospital Millennium Medical College Emergency Department from January 2018 to November 2023, Addis Ababa.
- To assess the associated factors associated with PLOS in patients with C-spine injury visited AaBET Hospital, affiliates of St. Paul's Hospital Millennium Medical College Emergency Department from January 2018 to November 2023, Addis Ababa.

4. Methods and Materials

4.1. Study area/Setting and Period

Institution based cross-sectional study was conducted from April 1, 2023 G.C. to Nov 30, 2023 G.C. The study was conducted at AaBET hospital, Arada sub city, Addis Abeba, Ethiopia. The hospital was inaugurated as a public hospital under SPHMMC in 2015, and it is one of the first health sector with an entire trauma and burn unit. It includes departments in Emergency medicine and critical care (EMCC), neurosurgery, orthopedics and traumatology and an academic program in plastic and reconstructive surgery. It has a well-structured emergency and ICU setup with more than 50 beds in the ED organized as red, orange and yellow green with 11 ICU beds and 3 semi-ICU beds. It provides 24 hours 7 days a week service with a comprehensive laboratory and radiography units. The later providing ultrasound, X-ray and CT scan service.

4.2. Study Design

Institution based cross sectional study was conducted in Aabet hospital.

4.3. Source Population

All patients with spine injury visited Emergency department of AaBET Hospital during the study period.

4.4. Study population

All patients with C-spine injury visited Emergency department of AaBET Hospital ED during the study period.

4.5. Eligibility

4.5.1. Inclusion criteria

All patients with C-spine injury visited Emergency department of AaBET Hospital during the study period.

4.5.2. Exclusion criteria

Any patient with incomplete documentation, unclear information and lost folder will be excluded from the study.

4.6. Sample Size Determination and Sampling Technique

4.6.1. Sample Size Determination

The sample size for the study was determined by assuming similar studies which were conducted in Tikur Anbessa Specialized Teaching Hospital (TASTH) showing among patient with spinal cord injury 33 % of patients have cervical spine injury. (26) The sample size was calculated using single population proportion formula. ([Table 2](#))

$$n = \frac{Z_{1-\alpha/2}^2 P(1 - P)}{E^2}$$

Where; - n = minimum sample size
P= the estimated prevalence of an indicator
 α =level of significance
E = desired precision
 $Z\alpha$ = the Z- score corresponding to 95% confidence interval= 1.96.

Table 2: The sample size calculation

Indicators	Information
Prevalence	33%
Level of significance(α)	5%
Z-score corresponding ($Z\alpha$)	1.96
Desired precision (E)	5%
Minimum sample size	339.7 $\approx$ 340

As the total number of patients with spinal cord injury (the source population) visited AaBET hospital ED during the study period was limited (410 patients), the correction formula for finite population was used.

Hence the minimum sample size calculated was corrected to 185 patients.

As the total number of patients with cervical spine injury visited AaBET hospital ED during the study period is estimated to be close to the minimum calculated sample size

So the researcher decided to include all patients with cervical spine injury patients visited AaBET Hospital ED during the study period.

Sample size Correction formula For finite population (<10,000)

$$n = \frac{n^{\circ}}{1 + ((n^{\circ} - 1) / N)}$$

n= Corrected sample size

n°= sample size calculated early

N= Total number of population in the study area

Figure 1: Correction formula

4.6.2. Sampling Technique

All patients with cervical spine injury during the study period was included.

4.7. Study Variables

4.7.1. Independent variable

- Age
- Sex
- ED arrival time
- Mechanism of trauma
- Level of Cervical spine injury
- Type of Cervical spine fracture
- ASIA class of the patient
- Neurogenic shock
- Associated injury
- Neurosurgical intervention.

4.7.2. Dependent variable

- Outcome of patients with C-spine injury at discharge (Dead or alive)
- Prolonged length of hospital stay.

4.8. Operational definition

Pattern: It is the distribution of C-spine injury by sex, age and mechanism of injury and residence among the study participants.

Primary Outcome: Conditions of patients with C-spine injury on discharge (dead or alive)

Secondary Outcome: Hospital length of stay

Neurologic improvement: If the patient has improvement in ASIA class (e.g. If improved from ASIA A to ASIA B)

Prolonged hospital stay (PLOS): Those patients with the hospital length of stay more than the 75th percentile.

4.9. Data Collection Method, Tools and Procedures

Data was collected from all eligible cervical spine injury patients charts using a structured data extraction format.

Nurses and interns from this hospital was recruited and trained as data collectors while principal investigators supervise the data collection process. Data was first cleaned manually and checklist that did not fulfill minimum criteria for completeness was rejected from entry. Data then entered to SPSS version 25 for analysis.

4.10. Data Quality control

Before data collection, training was given for data collectors and supervisors. During data collection data extraction tool was reviewed for completeness, accuracy and consistency by the principal investigator every day. The collected data was entered to computer software SPSS version 25 to check missing and incomplete data to avoid inconsistency.

4.11. Data Processing and Analysis

All charts of patients with C-spine injury visited AaBET Hospital from January 2018 to November 2023 G.C, was identified, collected and checked for its completeness using check list. The collected data was categorized first into appropriate groups for further analysis. The arranged data then entered into SPSS for analysis. Frequency and cross-tabulation were used to check for missed values and variables. The demographic and clinical characteristics of patients were computed by using descriptive statistics such as mean, percentage, frequencies, and standard deviation. To identify association between dependent and independent variable binary logistic regression was used with CI of 95%. P value of < 0.05 will be declared statistically significant association. Multivariate logistic regression was done to analyze all independent variable with dependent variables. The outcome of logistic regression stated that the logistic model is a good fit for the data set, since the Hosmer-Lemshow goodness of fit the p-value was 0.902 which is greater than 0.05. Additionally the pseudo R square, the regression result showed that the square of the correlation between the models predicted value and the actual value the outcome is 67.9%.

4.12. Ethical Consideration

This study used secondary data from patient charts. The data from the case records were handled with strong confidentiality. Ethical clearance and approval to conduct the research was obtained from St. Paul Hospital Millennium Medical College and department of emergency medicine and critical care, Addis Ababa. The study was started after obtaining ethical clearance from the board and after permission from the hospital management to review records. Owing to the retrospective design, the requirement for informed consent was waived.

4.13. Plan of Dissemination of results

The result of this study will be presented for partial fulfilment of the residency program. And it will be communicated to St Paul hospital millennium medical college, department of emergency medicine and critical care, Department of neurosurgery. The manuscript will also be sent to journals for possible publication and presentations (conferences, workshops).

5. RESULTS

5.1. The sociodemography

A total of 410 patients with Spine injury was found on the registration book and there was 30 lost charts and 9 incomplete charts was identified. So a total of 371 charts with spine injury was identified and from these all patient with cervical spine injury was included.

The study group (149 patients) consisted of 111 (74.5%) male and 38 (25.5%) female patients.

The overall male to female ratio was 2.9:1.

The mean age of the study population was 36.3 ± 14.9 years and it ranges from 9 to 85 years.

The peak age of incidence is the 21-30 years of age group. The majority of male patients sustained cervical spine injuries between 21 to 30 years of age, female patients exhibited injuries between the ages of 31-40 years. (See [Table 3](#))

Table 3: Sociodemographic data of the patients

Variables	Category	Frequency	percent
Age	≤ 20	17	11.4
	21-30	47	31.5
	31-40	39	26.2
	41-50	22	14.8
	51-60	13	8.7
	61-70	7	4.7
	71-80	2	1.3
	>81	2	1.3
Sex	Male	111	74.5
	Female	38	25.5

Address	Addis Ababa	31	20.8
	AFAR	3	2.0
	Amhara	23	15.4
	Gambella	2	1.3
	Oromia	73	49.0
	SNNPR	15	10.1
	Somali	1	.7
	Tigray	1	.7
	Total	149	100.0

The large proportion of patients are from Oromia and Addis Ababa which comprises of 73 (49.0%) and 31 (20.8%) of patients retrospectively. The remaining are from Amhara and SNNPR which consist of 23 (15.4%) and 15 (10.1%) of patients retrospectively. A small proportion of patients are from Afar, Gambella, Tigray and Somalia.

5.2. The prehospital and ED assessment

Among 149 patients included in the study which was seen at Emergency department 122 (81.9%) of patients were referred and the rest 27 (18.1%) of patients were non referral cases.

The median hours of ED arrival is 24 hours (IQR 44) and the minimum is 1 hour and the max is 360 hours (after 15 days).

When we see the relationship between ED arrival time and mode of referral, most of the non-referred patients come to ED earlier than those who are referred.

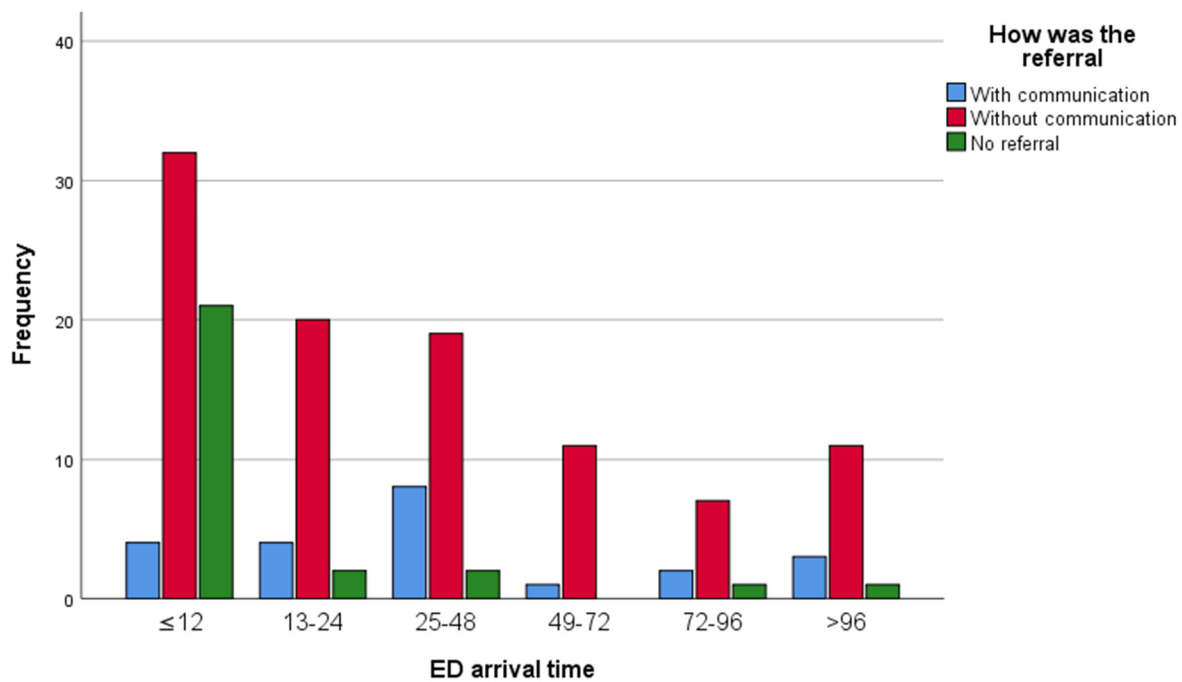


Figure 2 Arrival time and mode of referral

107 patients (71.8 %) with cervical spine injury triaged to yellow green area and only 18 patients (12.1%) was triaged to Red area. The rest 24 (16.1%) of patients triaged to Orange area. (Table 4).

When we see those patient triaged to Red area and time of ED arrival only 8 patients arrived in less than 12 hours. (Figure 1)

Table 4: Triage category of the patients

		ED arrival time					
		≤12	13-24	25-48	49-72	72-96	>96
Triage category of patients	Red	8	4	6	0	0	0
	Orange	10	5	5	2	1	1
	Yellow green	39	17	18	10	9	14

Hundred twenty four (83.2%) of patients had neck pain or tenderness at presentation. And Fifteen (10.1%) of patients had no neck pain, the rest ten (6.7%) of patients were difficult to assess.

Ninety three (62.4%) of patients come to ED without Cervical collar and the rest Fifty six (37.6%) of patient have Cervical collar in situ.

Among 122 patients who were referred from health facility only fifty six (45.9%) of patients referred with cervical collar in situ, the rest sixty six (54.1%) of patients referred without cervical collar placement. ([Table 5](#))

Table 5: C-collar utilization and referral

		How was the referral			
		With communication	Without communication	No referral	Total
C-collar applied during transportation	NO	7	59	27	93
	YES	15	41	0	56
Total		22	100	27	149

Among the studied population only 12 (8.1%) of patients had initial systolic Blood Pressure less than 90mmHg. And the rest 137 (91.9%) of patients had initial SBP in the range of 90-140mmHg. And there was no patients who have Systolic Blood Pressure greater than 140mmHg. And there was 4 (2.7%) of patients who had initial Heart rate less than 60 beats per minutes and 35 (23.5%) of patients who had heart rate greater than 100 beat per minutes, the remaining 110(73.8%) of patients have heart rate in the range of 60 to 100 beats per minutes.

Eleven (7.4%) of patient had neurogenic shock at ED presentation.

Eight (5.4%) of patients with cervical spine injury was intubated at Emergency Department. Among them seven patients were intubated for airway protection and one patient intubated for respiratory failure.

Among those who sustained cervical spine injury only two patients had Alcohol intoxication history.

Table 6: Clinical profile of the patients

Variables	Category	Frequency	Percent
Initial SBP	<90	12	8.1
	90-140	137	91.9
Initial HR	<60	4	2.7
	60-100	110	73.8
	>100	35	23.5
The mechanism of trauma	RTA	74	49.7
	FDA	59	39.6
	Assault	10	6.7
	A sharp object	1	.7
	Gunshot	3	2.0
	Hit by a falling object	1	.7
	Other	1	.7
ED disposition	Admitted to ward	27	18.1
	Discharged from ED with neurosurgery appointment.	61	40.9
	Referred to other facility	33	22.1
	Left against medical advice	9	6
	Admitted to ICU	12	8.1
	Died	7	4.7
ED length of stay in days	≤1	3	2.0
	1-7	100	67.1
	>7	46	30.9
	<7	86	57.7

Total Length of hospital stay	7-14	21	14.1
	15-28	24	16.1
	28-56	15	10.1
	>56	3	2.0

5.3. Mechanism of trauma

Among the studied population the most common cause of accident was Road traffic accident. Seventy four patients (49.7%) sustained injury by this mechanism, followed by falling down accident with fifty nine (39.6%) of patients. A small percentage of patient sustained cervical spine injury due to assault and gunshot.

When we see the mechanism of injury based on age category of the patient RTA is common in age group of 21-40 years and FDA is the most common mechanism of injury in age group greater than 41 years.

Among those who sustained RTA, Fifty eight patients were a passenger, ten were a pedestrian and only four of them was a driver.

From those who sustained RTA while they are in the car (the passenger and the driver) only 6 patients used seat belt, the three driver and the three passengers. The rest fifty six (90.3%) patients didn't used seat belt.

Among 59 patients who sustained falling down accident, 47 (79.6%) patients sustained FDA from height, 10 (17%) patients fall from a standing height and 2(3.4%) patients fall into a ditch.

When we see the relationship between the mechanism of falling down and the age of the patients, those aged from 21-50 years sustained injury by falling from the height. And the most majority of those age greater than 51 years sustained injury by falling from the standing height.

5.4. Associated injury

Seventy eight (52.3%) patients sustained a total of 114 associated injuries (ASOI). Among these Seventy patients (61.4%) sustained head injury, Twenty five (21.9%) patients sustained chest injury, Fourteen patients (12.3%) sustained extremity injury, Four patients (3.5%) sustained pelvis injury and One(0.9%) patient sustained abdominal injury.

From those who sustained head injury 51(72.9%) patients had Mild head injury, 12(17.1%) had Moderate head injury and 7(10%) had Severe head injury.

Most of the associated injury are resulted from RTA and FDA ([Table 7](#))

Table 7: Mechanism and associated injury

		Associated injury				
Mechanism of trauma		Head	Chest	Abdomen	Pelvis	Extremity
RTA		52	15	1	3	8
FDA		15	6	0	1	5
Assault		3	1	0	0	1
A sharp object		0	0	0	0	0
Gunshot		0	3	0	0	0
Hit by a falling object		0	0	0	0	0
Other		0	0	0	0	0
Total		70	25	1	4	14

5.5. Injury characterization

Fracture localization

A total of 288 cervical spine fracture occurred in 149 patients studied. The most frequently injured cervical vertebra was Cervical spine 7 (C 7) which comprises of 73 (26%), Cervical spine 6 (C 6) which comprises 72 (25.6%) and Thoracic vertebra 1(T1) which comprise 53(18.9%) of fracture. 102(68.5%) of the patient has multilevel injury. ([Figure 2](#))

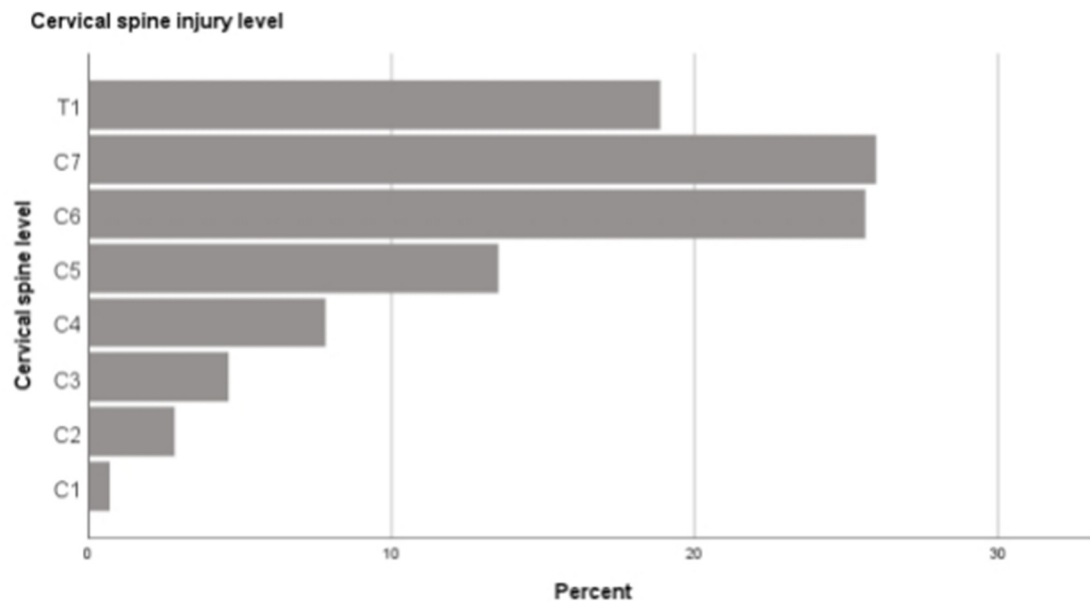


Figure 3: Distribution of C-spine injury level

Types of fracture

Most of the patient sustained burst fracture injury which comprise around Sixty six (28%) patients, followed by transverse process fracture which was about 64 (27.1%) patients and spinous process fracture which was around 52 (22.0%) patients.

Eight (3.4%) patients sustained hyper-extension teardrop fracture. Four (1.7%) patients sustained unilateral facet dislocation and three (1.3%) patients have cervical spinal cord injury without cervical spinal fracture. ([Figure 3](#))

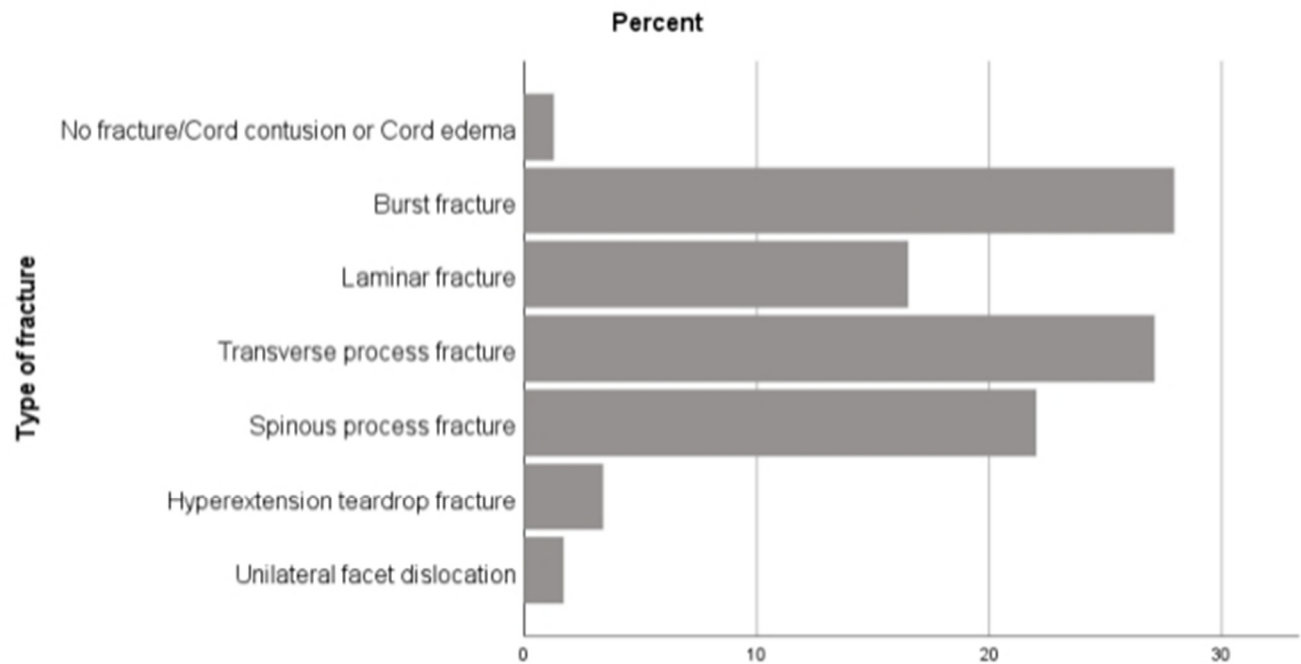


Figure 4: Type of fracture

Around 18 (12.1%) patients with cervical spine injury has concomitant spine injury at other site. Fifteen (10.1%) patient of which has associated thoracic vertebrae fracture and three (2%) patients has associated lumbar vertebrae fracture.

Neurological deficit

Among those who sustained cervical spine injury 50 (33.6%) of patients has neurological impairment ASIA class A, 44 (29.5%) of patients has ASIA class E. The rest 24 (16.1%) patients has ASIA class C, 20 (13.4%) patients ASIA class B and 11 (7.4%) patients has ASIA class D. ([Figure 4](#))

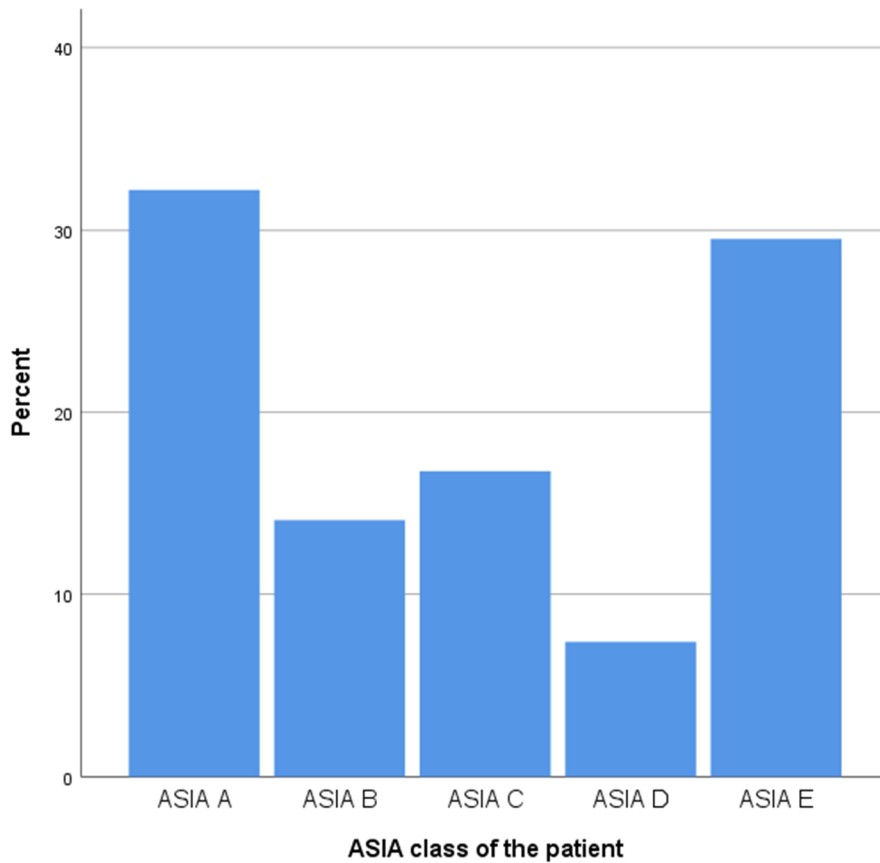


Figure 5: Neurologic deficit of the patients with c-spine injury

5.6. ED disposition

Among 149 patients seen at ED 27 (18.1%) of patients were admitted to the ward, 61(40.9%) patients discharged from ED with neurosurgical appointment, 33 (22.1%) patients referred to other facility, 9 (6%) patients Left against medical advice (LAMA), 12 (8.1%) patients admitted to ICU, 7(4.7%) patient died at ED. ([Table 6](#)).

From those 27 patients admitted to ward 23 patients undergo cervical spine surgery and 4 patients undergo cervical spine surgery among those patients admitted to ICU. ([Table 8](#))

Table 8: Neurosurgical intervention vs admission

		Admitted to ward	Admitted to ICU
Operated	Yes	23	4
	No	4	8
Total		27	12

Type 2 respiratory failure was the cause of death in all patients who died at ED.

The average ED length of stay was 6.4 days. Minimum stay was 1 day and max stay was 31 days.

Only 3 patients stayed in the ED for less than 24 hours. Most patients disposed from the ED within one week and around 46 patients stayed in the ED more than one week

The average length of total hospital stay in days for our studied population is 13.2 days. The minimum being one day and the maximum length of stay being 91 days.

When we do the percentiles, the 75th percentile for the length of hospital stay is 15 days. So we have 45 (30.2%) of patients stayed more than the 75th percentiles of length of stay.

From twelve patients admitted to ICU four patients died and the rest discharged alive. So the overall hospital mortality including the seven death at ED is 7.4% (11/149).

5.7. Factors associated with mortality

In this study all the independent variables that could affect mortality were included in the regression model. To determine the factors associated with mortality while controlling possible confounders, independent variables that yielded a p-value of ≤ 0.25 in binary logistic regression were exported to a multiple regression model to compute an adjusted odds ratio to quantify the strength of association with the dependent variable.

Hence variables like: age category, sex of the patient, level of cervical spine injury, ASIA class of the patient, presence of neurogenic shock and presence of associated injury were observed in the bivariate regression analysis to be associated with death.

After running a multivariable logistic analysis, the only variables that showed statistically significant association with mortality were the level of cervical spine injury, the ASIA class of the patient and the presence of associated injury were strongly associated for mortality. ([Table 9](#))

Table 9: Bivariate and multivariate Analysis to identify factors associated with mortality in patient with cervical spine injury

Variable		Death		COR(95%CI)	P-value	AOR(95%CI)	P- Value
		Yes	No				
Sex	F	1	37	3.66(0.45-29.6)	0.22		
	M	10	101				
Age	21-30	5	42	1.9 (0.21-17.6)	0.57		
	41-50	2	20	1.6 (.013-19.3)	0.71		
	61-70	1	6	2.66 (0.14-49.7)	0.51		
	>81	1	1	16.0(0.52-493.9)	0.11		
Level of Cervical spine injury	C3	3	10	9.23(0.77-111.6)	0.08	10.73(1.60- 71.66)	0.01
	C7	6	67	3.45(0.41-28.3)	0.25		
ASIA class of the patient	ASIA A			11.423(2.36-55.26)	0.02	23.65(2.48-225.25)	0.00
Neurogenic shock		3	8	6.09(1.35-27.49)	0.02		
Associated injury	Head Injury	7	63	1.19(0.28-5.02)	0.18	67.38(5.91- 767.44)	0.00
	Chest Injury	5	20	2.99(0.58-15.38)	0.19		
	Extremity	5	9	6.04(1.02-35.77)	0.05		

5.8. Factors associated with Long hospital stay

In this study all the independent variables that could be associated with long hospital length of stay were included in the regression model. To determine the factors associated with prolonged hospital stay (PLOS) while controlling possible confounders, independent variables that yielded a p-value of ≤ 0.25 in binary logistic regression were exported to a multiple regression model to compute an adjusted odds ratio to quantify the strength of association with the dependent variable.

Hence variables like: ASIA class of the patient, neurosurgical intervention, presence of associated injury and Hospital acquired infection were observed in the bivariate regression analysis to be associated with prolonged hospital stay (PLOS).

After running a multivariable logistic analysis, the only variables that showed statistically significant association with prolonged hospital stay (PLOS) were neurosurgical intervention and the presence of associated injury particularly patients having chest injury were strongly associated for prolonged hospital stay (PLOS). ([Table 10](#))

Table 10: Bivariate Analysis to identify factors associated Hospital PLOS in patient with cervical spine injury

Variable		PLOS		COR(95%CI)	P- value	AOR (95% CI)	P-value
		Yes	No				
ASIA Class	ASIA A	9	41	2.19(0.62-7.70)	0.219		
	ASIA B	11	8	13.75(3.48-54.28)	0.001		
	ASIA C	12	12	10.0(2.71-36.78)	0.005		
	Neurosurgical intervention	24	3	61.14(16.28-229.61)	0.01	32.63(5.46- 195.17)	0.00013
Hospital acquired infection		22	8	17.53(6.67-46.05)	0.01		
Associated injury							
	Chest injury	13	11	7.62(1.43-40.58)	0.017	32.97(4.38- 247.78)	0.00068

6. Discussion

Fractures of the cervical spine are a leading cause of morbidity and mortality in trauma patients, and a bone fracture is associated with 56% of cervical spinal cord injuries. (8) And it is a devastating, life changing condition, and poses a major challenge for clinicians to manage in resource constrained regions.

So an understanding of the pattern of cervical spinal injury and factors associated with poor outcome (death or prolonged hospital stay) is very important to develop possible preventive strategies and improve our primary trauma care.

Similar to other studies our study showed males are more commonly sustain cervical spine injury than females with a male to female ratio of 2.9:1. (22, 23, 25)

Mean age at the time of injury varies from 32.8 years from study in Addis Ababa Black lion Hospital, 34 years of age in Iran and to 56 years in Norway. (5, 22, 23). In accordance with most literature our review revealed that the mean age of the study population was 36.3 ($\pm$ 14.9) years with a peak age between 21-30 years, which is related with a more dynamic motor and vital activity.

Sixty two point five percent of patients with cervical spine/Spinal cord injury presented to our ED without cervical collar placement. Of those patients presented without cervical collar application around 44.3% of patients are referred from health institutions. The possible explanations for the underutilization of cervical collar could be lack of knowledge regarding care of trauma patients among the referring hospitals, unavailability of cervical collar and also absence of pre hospital care contribute to the low utilization of cervical immobilization. This finding is in contrary to most western practice where the problem is unnecessary C-spine immobilization. (27). In fact one international surveys of cohort of neurosurgeons and neurotrauma stakeholders, shows the use of prehospital cervical immobilization varied significantly by income status, with 36% ($\pm$ 35.6) of cases in low-income countries, 52.4% ($\pm$ 35.5) of cases in middle-income countries, and 95.2% ($\pm$ 10) in high-income countries, $P < 0.001$.(28).

On a global level, traffic accidents involving motor vehicles, bicycles, or pedestrians account for the greatest number of SCIs, typically 50% of all injuries. On a study conducted in Iran motor vehicle collisions are the most frequent trauma mechanism leading to cervical spine injury, with falls the second most frequent. (23, 29). Among the studied population the most common cause of accident was Road traffic accident. Seventy four patients (49.7%) sustained injury by this mechanism, followed by falling down accident with 59 (39.6%) of patients. A small percentage of patient sustained cervical spine injury due to assault and gunshot.

Most literature support the use of seatbelt significantly decrease the injury severity. One systematic review and meta-analysis assessing seatbelt use and risk of major injuries sustained by vehicle occupants during motor-vehicle crashes found that when analyzed by crash types, belt use significantly reduced the risk of any injury (RR 0.35; 95%CI, 0.24 to 0.52). Seatbelt use reduces the risk of facial injuries (RR = 0.56, 95% CI = 0.37 to 0.84), abdominal injuries (RR = 0.87; 95% CI = 0.78 to 0.98) and, spinal injuries (RR = 0.56, 95% CI = 0.37 to 0.84). (31).

in our study among the driver and passengers who sustained RTA seatbelt use was very poor, with only 9.7% of them used seatbelt. This finding is almost similar with most study in developing country regarding seatbelt use. (31, 32). The reason for low seatbelt usage can be multifactorial, which include lack of awareness of the importance of seatbelts, inadequate enforcement of seatbelt laws, and a lack of access to seatbelt.

Associated injuries were a common finding in this study population. Seventy eight (52.3%) patients sustained a total of 114 associated injuries (ASOI). Head injury is the most common associated injury followed by Chest injury and Extremity injury. This finding agree with the report of LA Saboe et al which identified the presence of associated injuries in 240 (47%) individuals, most frequently involving head (26%), chest (24%), or long bones (23%). (33). Also Philipp Leucht et al 2008 reported that the most common associated injuries were those to the head, thorax and extremities. (24).

The most frequently injured cervical vertebra was Cervical spine 7 (C 7) which comprises of 73 (26%), Cervical spine 6 (C 6) which comprises 72 (25.6%) and Thoracic vertebra 1(T1) which comprise 53(18.9%) of fracture. 102(68.5%) of the patient has multilevel injury. A study done by Higashi T et al and colleagues showed the level of injury was distributed from C3 to T1, most of the injuries occurred at the level of C4 (30%) and C5 (33%). (34).

More than half of cord injuries are thought to be incomplete (22, 34), similarly our study revealed, about 66.4% (99/149) patients had incomplete injury or no neurological deficit at all. Only 33.6 % of the patients with cervical spinal cord injury had ASIA A scale.

Several studies has reported the mortality rate of patient having cervical spine cord injury from 19 % from one of the population study in Norway to 63.9 % in one of the retrospective multi-center study conducted in German in patient with high cervical spine injury. (3, 22, 35, 36, 37). In contrast to the above studies the mortality rate in our study is 7.4 %. The discrepancy can be partly attributed to the clinico-demographic differences of the studied population. For instance the study conducted in Germany included those patients who sustained severe cervical spine injury with an abbreviated injury score (AIS) of 6, while the study conducted in Norway even though they excluded those patient with associated severe head injury and those patients with multiple site injury which could contribute to the mortality in patients with cervical spine injury, the mean age of the study population were 80 years (range 65-101 years), while the mean age in the current study is 36.3 ± 14.9 years (ranges 9-85 years). Hence, among others younger age might contribute to the lower mortality rate.

Although most literature reported that older age was significantly associated with the risk of death due to traumatic SCI. In this study, the age of the deceased group was 50 years or lower. (3, 36). In our study the age is not associated with mortality.

Cervical spinal cord injury often causes severe long-time disability due to neurological deficit. Multiple studies have shown that severe paralysis was associated with mortality. This study also shows that an ASIA impairment scale of A was a significant risk factor for mortality in traumatic cervical SCI. It was documented in one study that paralysis of the chest wall and abdominal muscles can lead to respiratory compromise and the need for prolonged mechanical ventilation.

Complete paralysis, even in lower cervical SCI, can influence both groups of muscles, causing serious respiratory problems. (34, 38, 39)

The association between the level of cervical spinal cord injury and mortality is controversial. Higashi T et al [34] reported that the level of neurological impairment was not significant risk factor of mortality. Conversely, Shao et al [38] reported that upper level cervical cord injury is a risk factor of early mortality in patients with cervical SCI. In agreement with the later study, the results of this study states that the level of neurological impairment was a significant risk factor of mortality.

Ali R. Bokhari et al reported that significant predictive factors for complications and death in patient with cervical spine injury were neurological deficits, comorbidities and the presence of other injuries ($P < 0.05$) and the most common concomitant injuries were long bone fractures (11.6%), rib fractures (11.1%) and head injuries (7.6%) (40). In agreement with the above study, in our study 9.4 % of patients has extremity injury and associated with mortality (P value=0.00).

Katherine E. Pierce et on his paper factors influencing length of stay following cervical spine surgery did LOS outcome analysis grouping patients by length of inpatient hospital stay: extended (E-LOS; >75th percentile) and normal (N-LOS; <75th percentile).(42). And Kazuyoshi Kobayashi, MD on his multicenter study assessing predictors of prolonged length of stay after lumbar interbody fusion, categorized patients as having a normal LOS (<75th percentile LOS) or prolonged LOS (>75th percentile LOS. (43). in this study we have 45 (30.2%) of patients stayed more than the 75th percentiles of length of stay which is 15 days.

And longer hospital length of stay (LOS) has been associated with many undesirable consequences. Prolonged LOS has been shown to increase healthcare costs and resource utilization. Factors significantly associated with longer LOS were advanced patient age, emergency admission, ASIA grade, operative management and the occurrence of one or more associated injuries. (41). In agreement with the above study ASIA A neurologic deficit and neurosurgical intervention significantly associated with the prolonged hospital stay.

7. Limitations of the study

The constraints of any retrospective study applied to this one as well, such as the need to adjust for confounding variables. The study's scope was restricted to evaluating in-hospital mortality; long-term mortality was not examined. Factors affecting mortality in a patient with cervical spine injury like the patient preexisting comorbidity, the patient condition in ICU like duration of mechanical ventilation, tracheostomy need are not included in the analysis. And Institutional, social and personal factors that can potentially affect the hospital length of stay are not included in the analysis.

Finally the study was conducted at a single center with a relatively limited number of sample size, and thus, the findings may not be generalizable.

8. Conclusion and recommendations

8.1 Conclusion

This study showed the common mechanism of injury was RTA and C7 was the common injury level. C3 injury level, ASIA A neurologic deficit and having associated injury were associated with mortality. Undergoing neurosurgical intervention and the presence of associated injury were associated with prolonged length of hospital stay (PLOS).

8.2 Recommendations

Based on the result of the study the following recommendations are forwarded.

For AaBET hospital, it is recommended to expand the operative and bed capacity of the hospital so that it can decrease the referral out rate of patients with cervical spine injury patients.

For referring hospitals and health institutions, it is recommend to identify the gaps for underutilization of cervical spine collar for patients with cervical spine injury and improves its utilizations.

For the road traffic safety office, and individual drivers and passengers, it is recommended to create awareness on the importance of seatbelt use and enforce seatbelt law, as most of the driver and passengers who sustained cervical spine injury didn't used seatbelt based on this study.

For future researchers since this study only focused on the in hospital mortality following cervical spine injury, it is recommended to do further study to see the outcome of discharged patients with cervical spine injury.

9. References

1. Torretti JA, Sengupta DK. Cervical spine trauma.
2. Marcon RM, Cristante AF, Teixeira WJ, Narasaki DK, Oliveira RP, Pessoa de Barros Filho TE. Fractures of the cervical spine. *Clinics*. 2013 Nov; 68 (11):1455–61.
3. Mitchel Harris BB, Reichmann WM, Bono CM, Bouchard K, Corbett KL, Warholc N, et al. Mortality in Elderly Patients After Cervical Spine Fractures. *J BONE Jt Surg*. 2010;
4. Fielingsdorf K, Dunn RN. Cervical spine injury outcome--a review of 101 cases treated in a tertiary referral unit. *South Afr Med J Suid-Afr Tydskr Vir Geneeskde*. 2007 Mar; 97 (3):203–7.
5. Short-Term Outcome in Subaxial Spine Injury Patients Operated on in a Resource-Limited Setting, Addis Ababa, Ethiopia. *World Neurosurg*. 2018 May 1; 113:e702–6.
6. National Spinal Cord Injury Statistical Center. Spinal cord injury facts and figures at a glance. *J Spinal Cord Med*. 2013 Jan; 36 (1):1–2.
7. Shah G, Dhakal GR, Gupta A, Hamal PK, Dhungana S, Poudel S. Outcome of Cervical Spine Trauma Patients Admitted to the Intensive Care Unit at a Tertiary Government Referral Trauma Center in Nepal. *Glob Spine J*. 2022 Sep; 12 (7):1388–91.
8. Spinal cord injury [Internet]. Available from: <https://www.who.int/news-room/fact-sheets/detail/spinal-cord-injury>
9. Chiu WT, Lin HC, Lam C, Chu SF, Chiang YH, Tsai SH. Epidemiology of traumatic spinal cord injury: Comparisons between developed and developing countries. *Asia Pac J Public Health*. 2010; 22 (1):9–18.
10. Chhabra HS, Arora M. Demographic profile of traumatic spinal cord injuries admitted at Indian spinal injuries Centre with special emphasis on mode of injury: A retrospective study. *Spinal Cord*. 2012;50 (10):745–54.
11. Greenbaum J, Walters N, Levy PD. An evidenced-based approach to radiographic assessment of cervical spine injuries in the emergency department. *J Emerg Med*. 2009 Jan;36 (1):64–71.
12. Snell RS. Clinical anatomy for emergency medicine / Richard S. Snell, Mark S. Smith. St. Louis: Mosby; 1993. xiii+862.
13. Maroon JC, Abla AA. Classification of acute spinal cord injury, neurological evaluation, and neurosurgical considerations. *Crit Care Clin*. 1987 Jul;3(3):655–77.
14. Krüger A, Oberkircher L, Frangen T, Ruchholtz S, Kühne C, Junge A. Fractures of the occipital condyle clinical spectrum and course in eight patients. *J Craniovertebral Junction Spine*. 2013;4(2):49–55.
15. Leone A, Cerase A, Colosimo C, Lauro L, Puca A, Marano P. Occipital condylar fractures: a review. *Radiology*. 2000 Sep;216(3):635–44.
16. Levine AM, Edwards CC. Treatment of injuries in the C1-C2 complex. *Orthop Clin North Am*. 1986 Jan;17(1):31–44.

17. Anderson LD, D'Alonzo RT. Fractures of the odontoid process of the axis. *J Bone Joint Surg Am.* 1974 Dec;56(8):1663–74.
18. Clark CR, White AA. Fractures of the dens. A multicenter study. *J Bone Joint Surg Am.* 1985 Dec;67(9):1340–8.
19. Leonard JR, Jaffe DM, Kuppermann N, Olsen CS, Leonard JC, Nigrovic LE, et al. Cervical spine injury patterns in children. *Pediatrics.* 2014;133(5).
20. Clayton JL, Harris MB, Weintraub SL, Marr AB, Timmer J, Stuke LE, et al. Risk factors for cervical spine injury. *Injury.* 2012 Apr;43(4):431–5.
21. Brown RL, Brunn MA, Garcia VF. Cervical spine injuries in children: a review of 103 patients treated consecutively at a level 1 pediatric trauma center. *J Pediatr Surg.* 2001 Aug;36(8):1107–14.
22. Linnerud Fredø H, Ali Mujtaba Rizvi S, Lied B, Rønning P, Helseth E. The epidemiology of traumatic cervical spine fractures: a prospective population study from Norway [Internet]. 2010. Available from: <http://www.sjtreem.com/content/20/1/85>
23. Yadollahi M, Paydar S, Ghaem H, Ghorbani M, Mousavi SM, Akerdi AT, et al. Epidemiology of cervical spine fractures. *Trauma Mon.* 2016 Jul;21(3).
24. Leucht P, Fischer K, Muhr G, Mueller EJ. Epidemiology of traumatic spine fractures. *Injury.* 2009 Feb;40(2):166–72.
25. Debebe F, Woldetsadik A, Laytin AD, Azazh A, Maskalyk J. The clinical profile and acute care of patients with traumatic spinal cord injury at a tertiary care emergency centre in Addis Ababa, Ethiopia. *Afr J Emerg Med.* 2016 Dec 1;6(4):180–4.
26. Biluts H, Abebe M, Laeke T, Tirsit A, Belete A. PATTERN OF SPINE AND SPINAL CORD INJURIES IN TIKUR ANBESSA HOSPITAL, ETHIOPIA. 2015 Apr 1;53:75–82.
27. Muzyka L, Bradford JM, Teixeira PG, DuBose J, Cardenas TCP, Bach M, Ali S, Robert M, Brown CVR. Trends in prehospital cervical collar utilization in trauma patients: Closer, but not there yet. *Acad Emerg Med.* 2023 Oct 13. doi: 10.1111/acem.14822. Epub ahead of print. PMID: 37828864.
28. Jacob R. Lepard, Saniya Mediratta, Andres M. Rubiano, Kee B. Park, The Application of Guideline-Based Care for Traumatic Brain and Spinal Cord Injury in Low- and Middle-Income Countries: A Provider-Based Survey.
29. Pirouzmand F. Epidemiological trends of spine and spinal cord injuries in the largest Canadian adult trauma center from 1986 to 2006. *J Neurosurg Spine.* 2010 Feb;12 (2):131-40. doi: 10.3171/2009.9.SPINE0943. PMID: 20121346.
30. Ojo TK. Seat belt and child restraint use in a developing country metropolitan city. *Accid Anal Prev.* 2018 Apr; 113:325-329. doi: 10.1016/j.aap.2018.02.008. Epub 2018 Mar 7. PMID: 29477798.
31. Fouda Mbarga N, Abubakari AR, Aminde LN, Morgan AR. Seatbelt use and risk of major injuries sustained by vehicle occupants during motor-vehicle crashes: a systematic review

- and meta-analysis of cohort studies. *BMC Public Health*. 2018 Dec 29;18(1):1413. doi: 10.1186/s12889-018-6280-1. PMID: 30594164; PMCID: PMC6310927.
32. Hauswald M. Seat belt use in a developing country: covert noncompliance with a primary enforcement law in Malaysia. *Accid Anal Prev*. 1997 Sep;29 (5):695-7. doi: 10.1016/s0001-4575(97)00004-3. PMID: 9316717.
 33. Saboe LA, Reid DC, Davis LA, Warren SA, Grace MG. Spine trauma and associated injuries. *J Trauma*. 1991 Jan;31(1):43-8. doi: 10.1097/00005373-199101000-00010. PMID: 1986132.
 34. Higashi T, Eguchi H, Wakayama Y, Sumi M, Saito T. Risk factors associated with mortality after traumatic cervical spinal cord injury. *OTA Int*. 2018 May 16;1(1):e003. doi: 10.1097/OI9.0000000000000003. PMID: 33937641; PMCID: PMC7953704.
 35. Chhabra, H.S., Sharawat, R. & Vishwakarma, G. In-hospital mortality in people with complete acute traumatic spinal cord injury at a tertiary care center in India—a retrospective analysis. *Spinal Cord* **60**, 210–215 (2022). <https://doi.org/10.1038/s41393-021-00657-x>
 36. Kamp, O., Jansen, O., Lefering, R. *et al*. Survival among patients with severe high cervical spine injuries – a TraumaRegister DGU® database study. *Scand J Trauma Resusc Emerg Med* **29**, 1 (2021). <https://doi.org/10.1186/s13049-020-00820-y>
 37. Pickett GE, Campos-Benitez M, Keller JL, Duggal N. Epidemiology of traumatic spinal cord injury in Canada. *Spine (Phila Pa 1976)*. 2006 Apr 1;31 (7):799-805. doi: 10.1097/01.brs.0000207258.80129.03. PMID: 16582854.
 38. Shao J, Zhu W, Chen X, Jia L, Song D, Zhou X, Yan W, Zhang Y. Factors associated with early mortality after cervical spinal cord injury. *J Spinal Cord Med*. 2011 Nov; 34 (6):555-62. doi: 10.1179/2045772311Y.00000000024. PMID: 22330110; PMCID: PMC3237281.
 39. Harris MB, Reichmann WM, Bono CM, Bouchard K, Corbett KL, Warholc N, Simon JB, Schoenfeld AJ, Maciolek L, Corsello P, Losina E, Katz JN. Mortality in elderly patients after cervical spine fractures. *J Bone Joint Surg Am*. 2010 Mar; 92 (3):567-74. doi: 10.2106/JBJS.I.00003. PMID: 20194314; PMCID: PMC2827825.
 40. Sokolowski MJ, Jackson AP, Haak MH, Meyer PR Jr, Sokolowski MS. Acute mortality and complications of cervical spine injuries in the elderly at a single tertiary care center. *J Spinal Disord Tech*. 2007 Jul;20(5):352-6. doi: 10.1097/BSD.0b013e31802d0bc5. PMID: 17607099.
 41. Hindi MN, Dandurand C, Ailon T, Boyd M, Charest-Morin R, Dea N, Dvorak MF, Fisher C, Kwon BK, Paquette S, Street J. Factors contributing to a longer length of stay in adults admitted to a quaternary spinal care center. *Eur Spine J*. 2023 Mar; 32 (3):824-830. doi: 10.1007/s00586-023-07547-1. Epub 2023 Jan 28. PMID: 36708396; PMCID: PMC9883608.
 42. Pierce KE, Gerling MC, Bortz CA, Alas H, Brown AE, Woo D, Vasquez-Montes D, Ayres EW, Diebo BG, Maglaras C, Janjua MB, Buckland AJ, Fischer CR, Protopsaltis TS, Passias PG. Factors influencing length of stay following cervical spine surgery: A comparison of

myelopathy and radiculopathy patients. *J Clin Neurosci*. 2019 Sep; 67:109-113. doi: 10.1016/j.jocn.2019.06.009. Epub 2019 Jun 15. PMID: 31213384.

43. Kobayashi K, Ando K, Kato F, Kanemura T, Sato K, Hachiya Y, Matsubara Y, Kamiya M, Sakai Y, Yagi H, Shinjo R, Ishiguro N, Imagama S. Predictors of Prolonged Length of Stay After Lumbar Interbody Fusion: A Multicenter Study. *Global Spine J*. 2019 Aug;9(5):466-472. doi: 10.1177/2192568218800054. Epub 2018 Sep 13. PMID: 31431867; PMCID: PMC6686383.